Global Analyzer Systems Ltd.

Innovative True NO_2 Converter

- Enabling a Chemiluminescent NO_x Analyzer to Measure 'True' NO_2 -

Presented by:

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Presented at:

2017 CPANS CONFERENCE AND AGM

Edmonton, AB

May 9, 2017

Air & Waste Management Association

Canadian Prairies and Northern Section

Presentation Outline

1) Project Objectives
2) Atmospheric Chemistry of NO_x (Summary)
3) Upgrading a Chemiluminescent Analyzer
4) Field Trials
5) Conclusions

Project Objectives

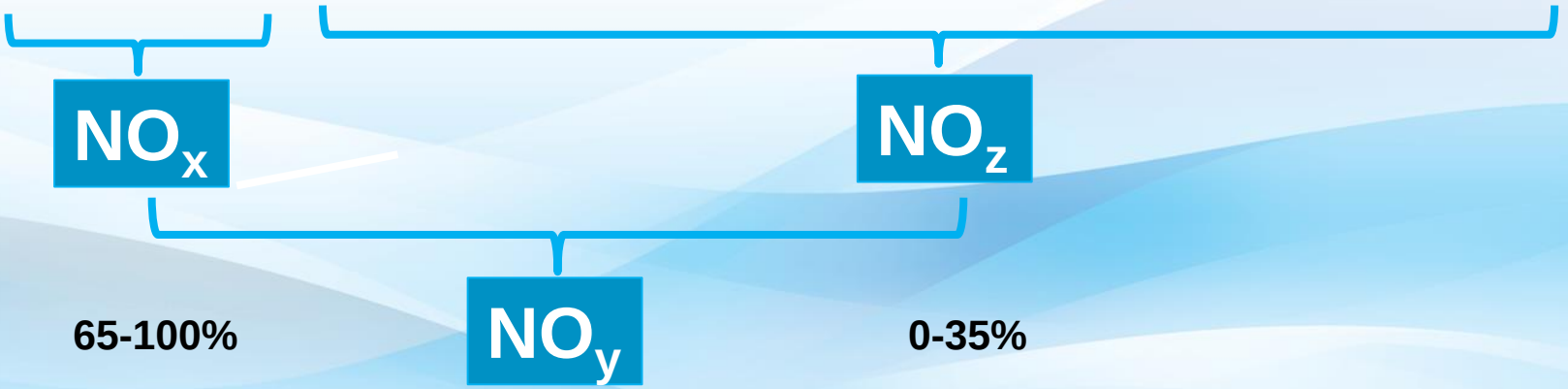
Create a device that enables existing analyzers to SELECTIVELY measure NO_2

- Linear conversion over a wide dynamic range
- Simple external installation
- Fast response & high resolution
- Conversion efficiency >95%

In order to….

- Reduce the potential over-reporting of NO_X
- Meet evolving Federal Regulations

NO_X, NO_Y, NO_Z & Chemiluminescence



$$NO_y = NO_x + HNO_3 + NO_3^- + PANs + NH_3 + ClNO_2 + 2N_2O_5 \ldots$$

Current NO_2 Measuring Methods

Option A:

Direct Measurement

Option B (most common):

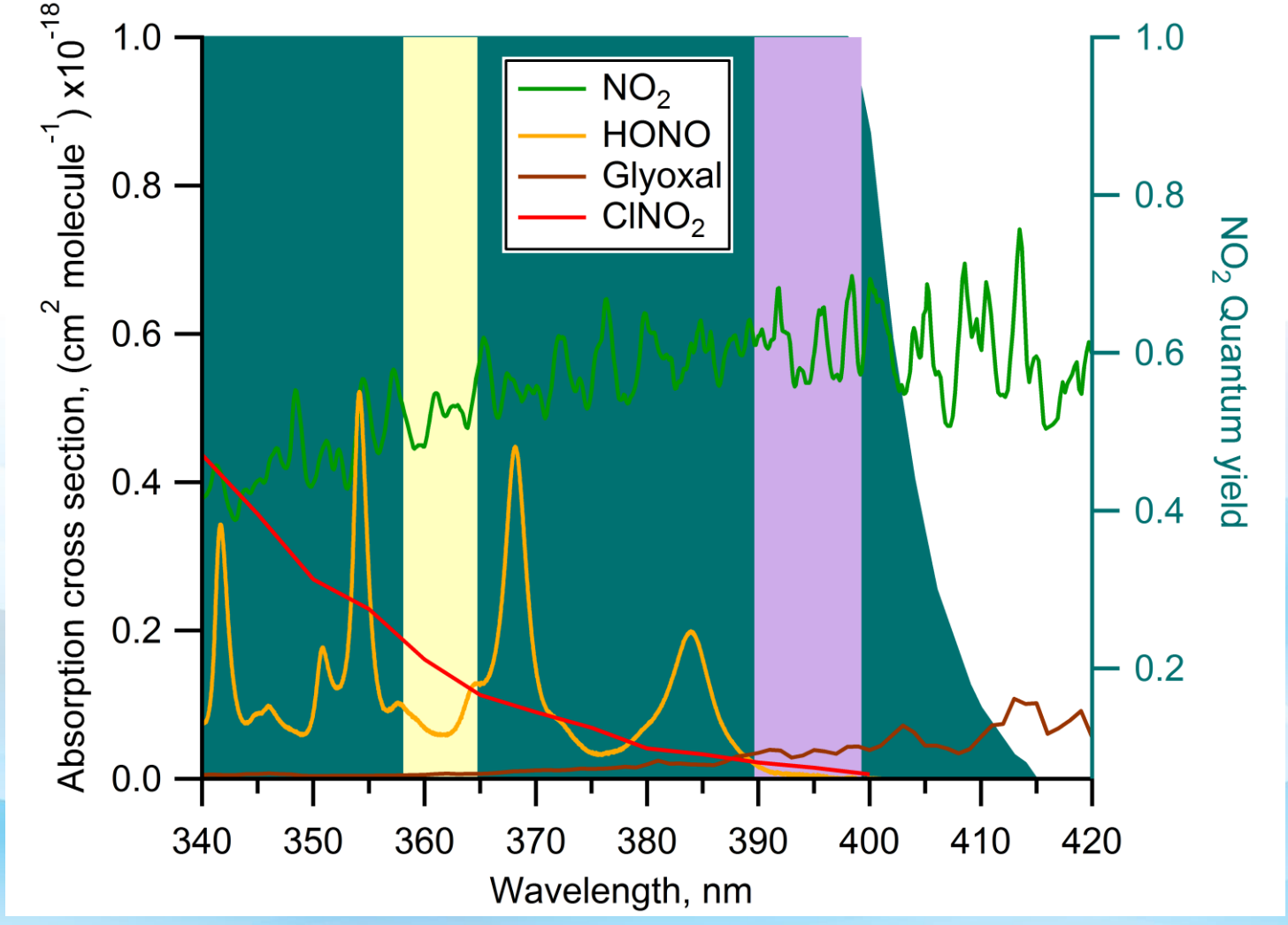
Indirect Measurement

(via Chemiluminescence)

1) Heated Metal Converters (Mo/SS)
   - + Efficient
   - + Long Life
   - + Reliable
   - - NOT SPECIFIC

2) Photolytic Converter
   - + Selective to only NO_2

Selective NO_2 Photolysis



J.P. Burrows, et al., *J. Quant. Spectrosc. Radiat. Transfer* **60**, 1025-1031 (1998)

J. Stutz, et al., *J. Geophys. Res.* **105**, 14585-14592 (2000)

S.P. Sander, et al., *JPL Publication* **10-6**, Jet Propulsion Laboratory, Pasadena, 2011. http://jpldataeval.jpl.nasa.gov

NO_x, NO_y, NO_z & Chemiluminescence

Understanding NO_2: Changing the status quo

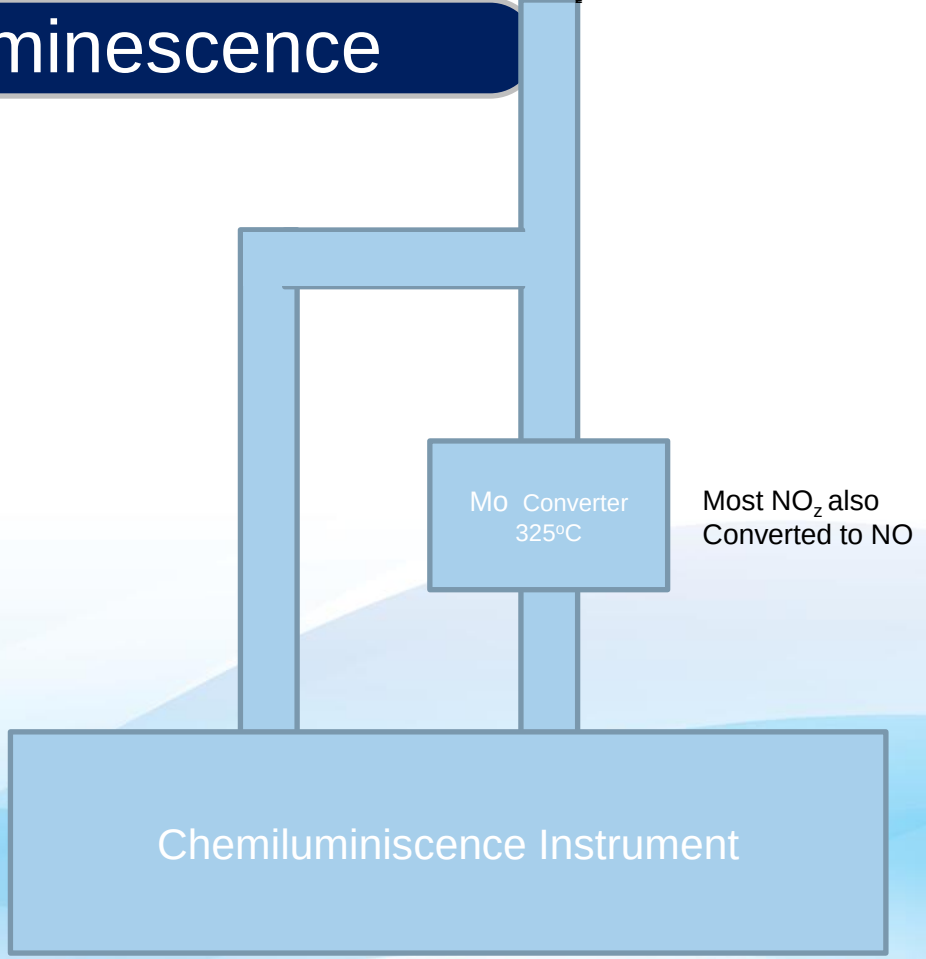
Definitions :

$NO_y = \Sigma(NO + NO_2 + HNO_3 +$ organic nitrates + particulate nitrates + chlorine nitrates+ nitrate radical + more)

NO_y is the sum of oxidized reactive nitrogen

NO_x = $NO + NO_2$ (ideal case)

NO_z = $NO_y - NO_x$



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NO_x, NO_y, NO_z & Chemiluminescence

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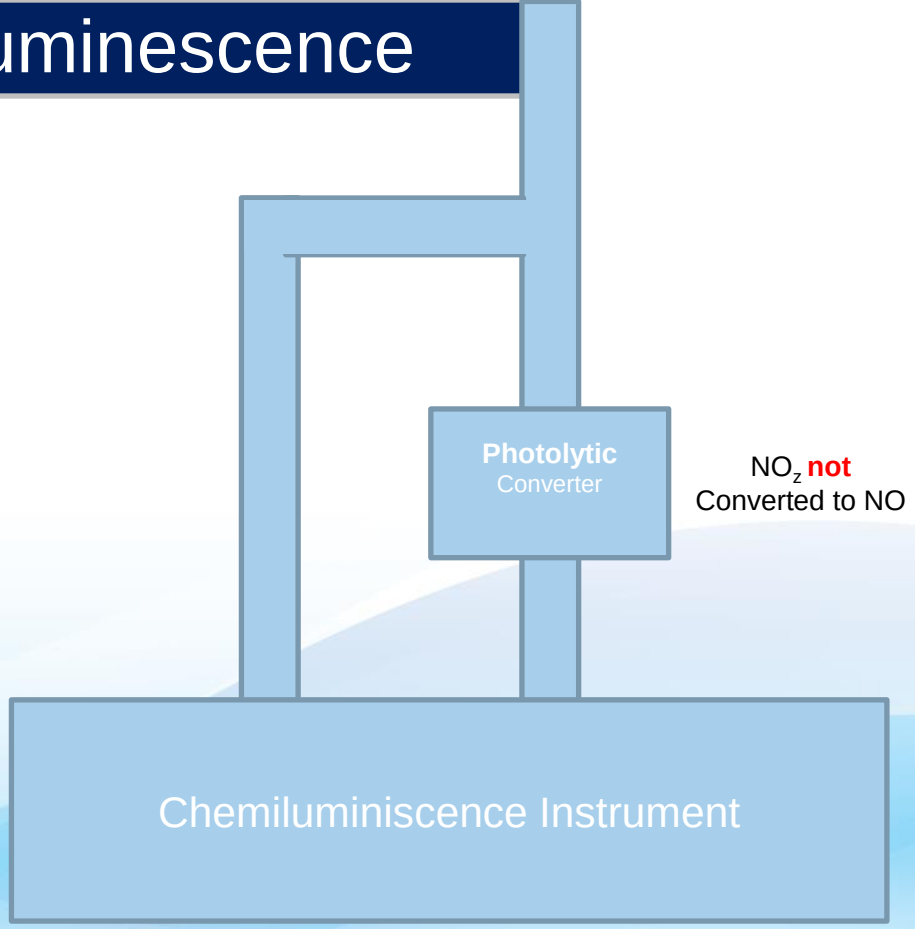
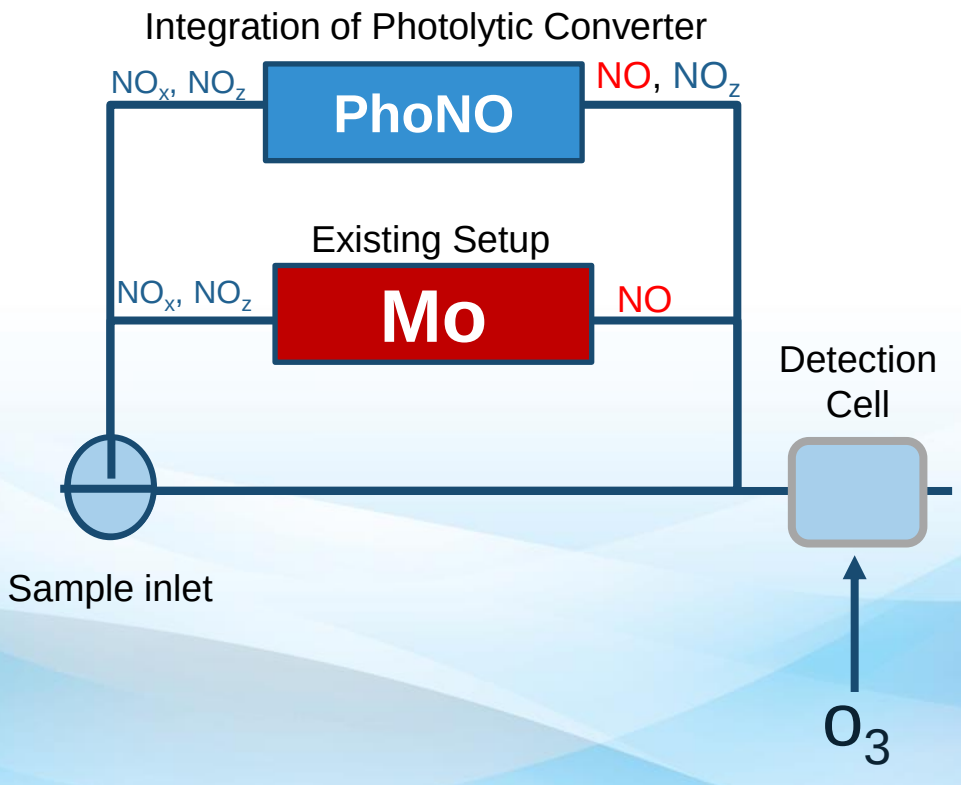


Global's Approach



Field Trial Set-Up

Sample Line/
Calibration Line

Global's PhoNO™
Converter

To PhoNO™ System

Chemiluminescent Analyzer
(42i for FAP Deployment)

Data Acquisition System
(eICIS)

To Existing Analyzer

Existing AQM
Chemiluminescent
Analyzer

To Exhaust

1. Tie in to Sample Line (and Calibration Line)
2. Tie into Exhaust Line

Simple and Fast Tie-in!

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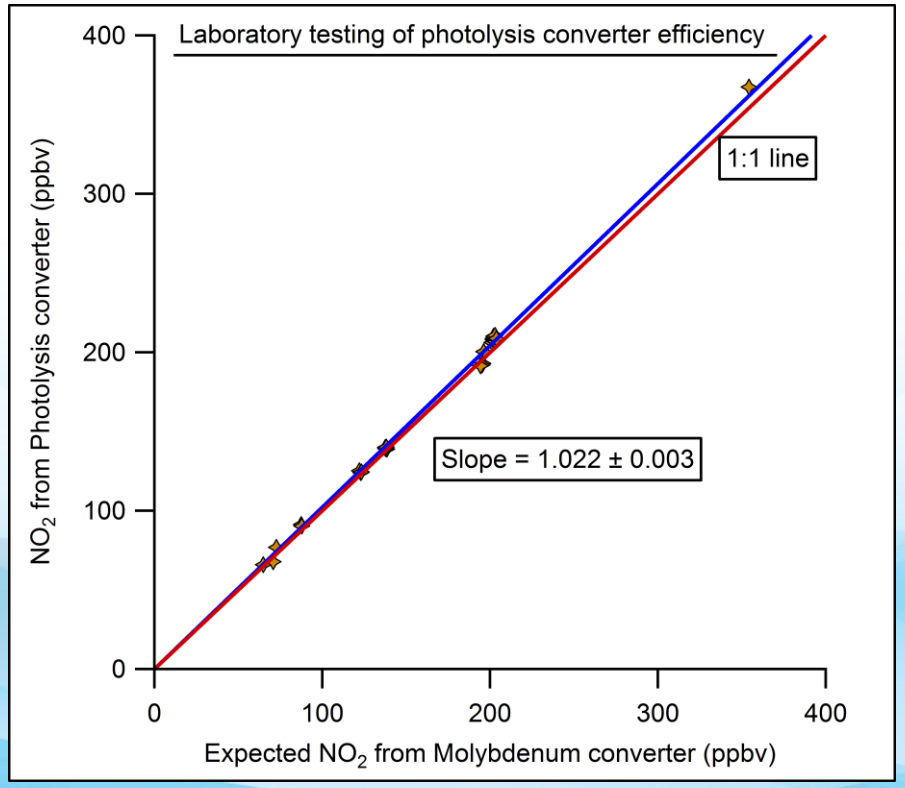
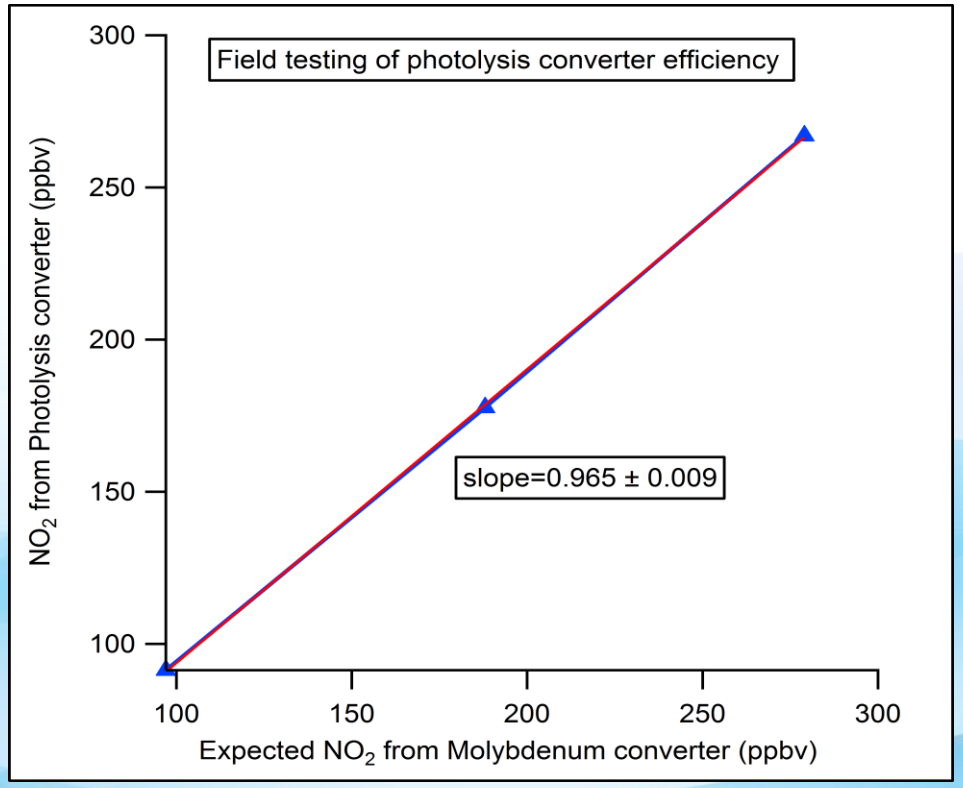
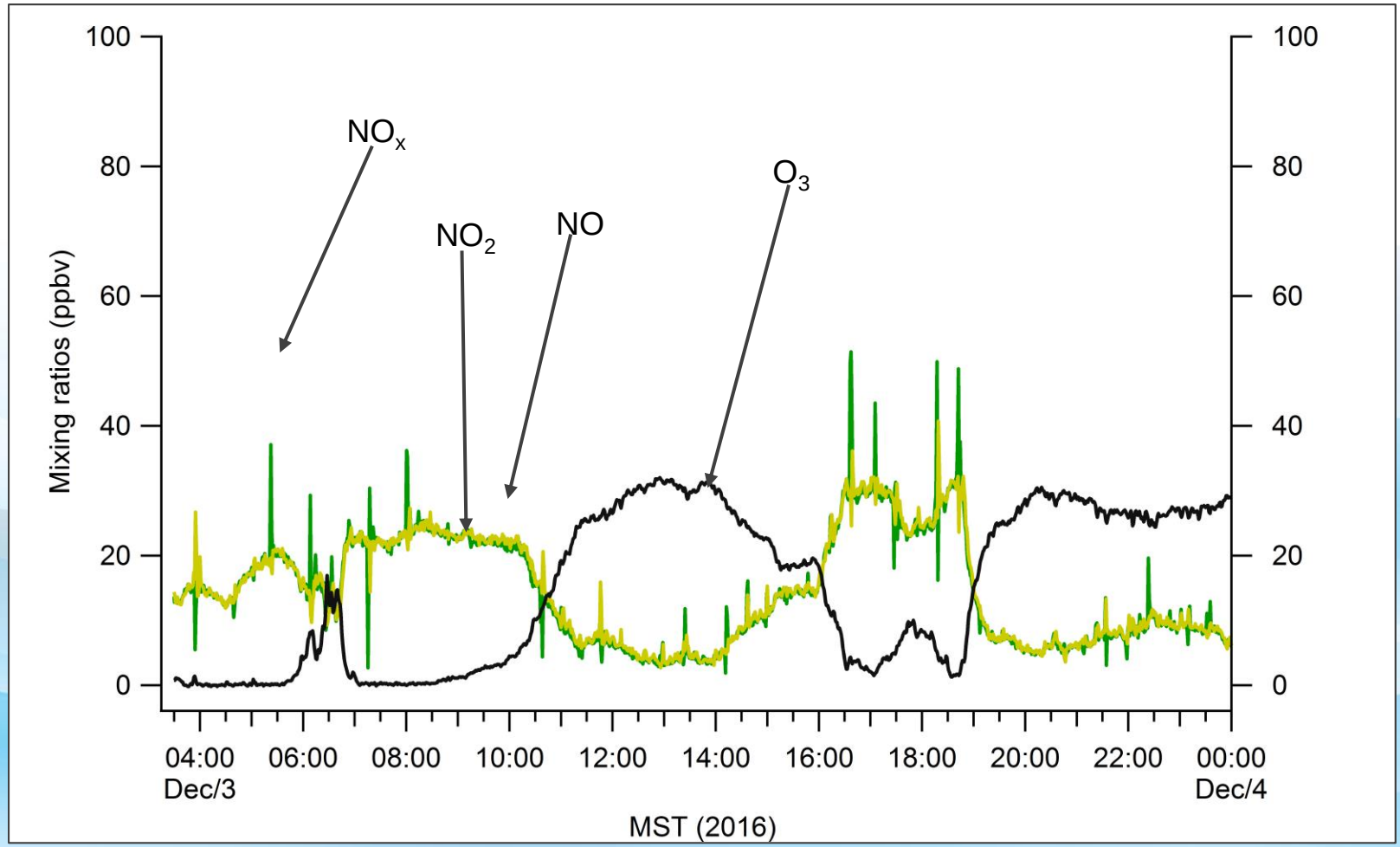
Calibration of PhoNO

Up to 37 ppm tested
and the device conversion rate is linear!!

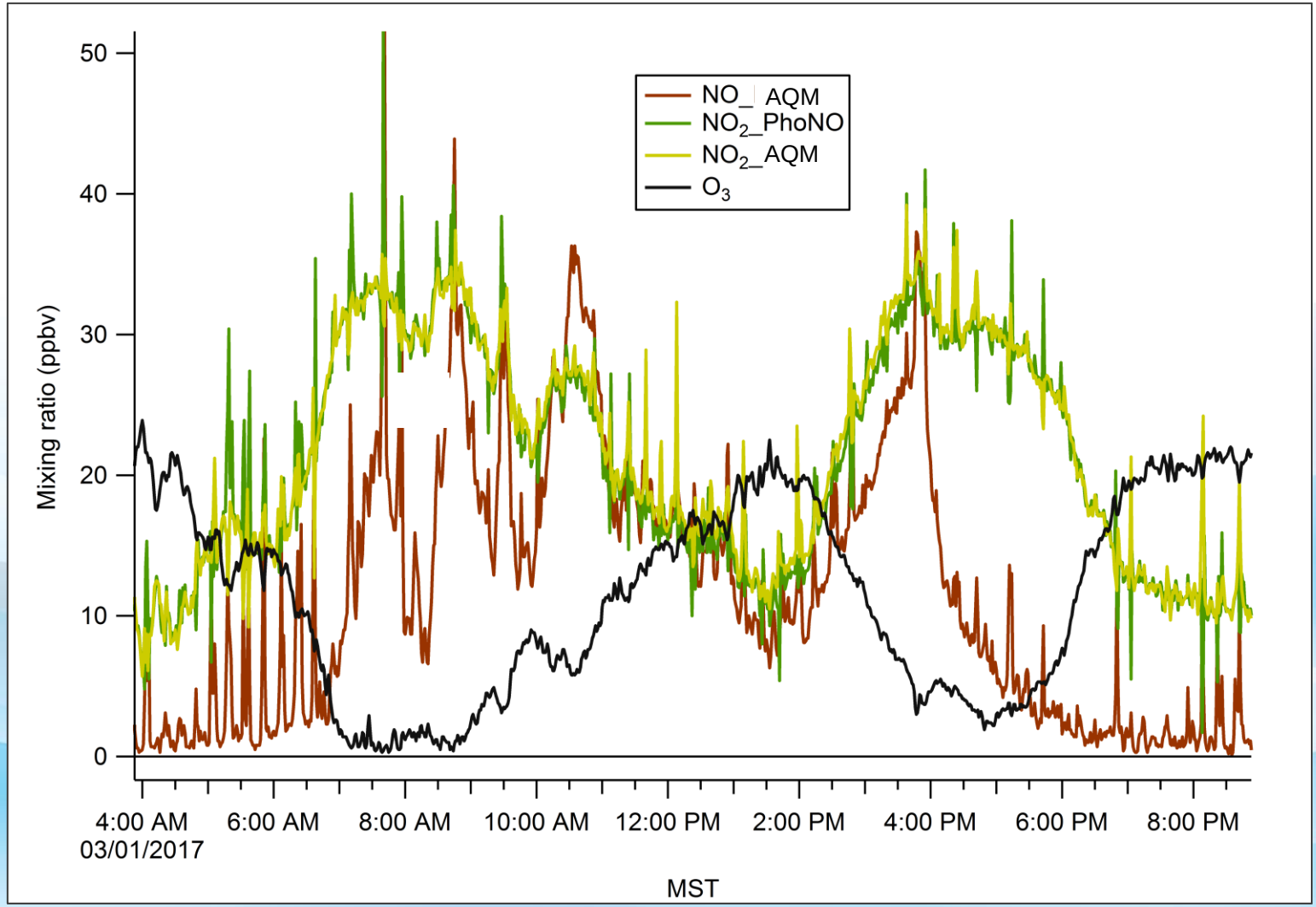




Field deployment of PhoNO

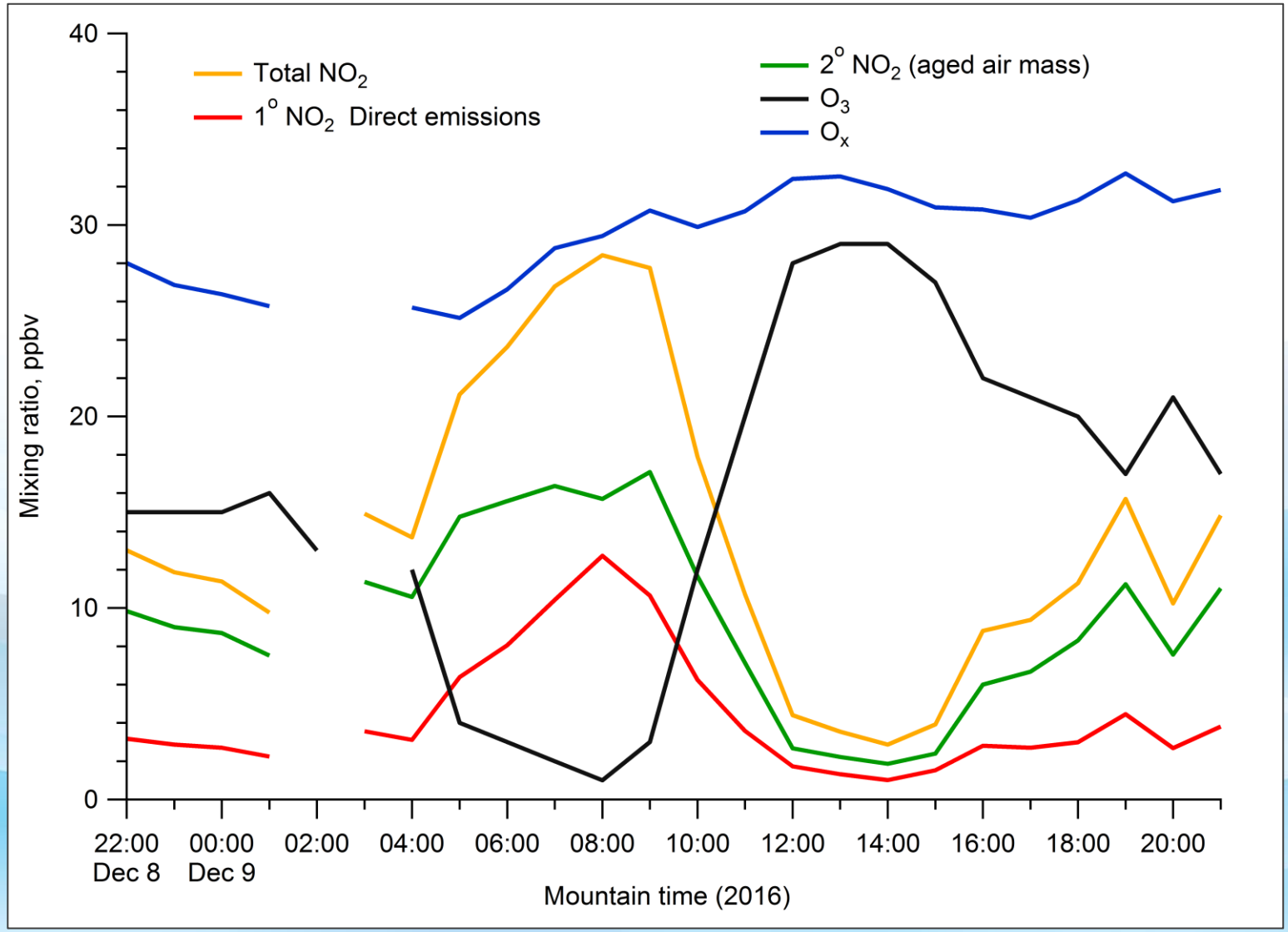


High resolution of PhoNO



Odame-Ankrah, CA, et al. (**2017**), unpublished

Why Quality Assured Data?



Emission ratio (NO_2/NO_x) = O_x vs NO_x

$O_x = O_3 + NO_2$
$NO_x = NO + NO_2$

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Anttila P, Tuovinen J-P, & Niemi JV (2011) *Atmospheric Environment* 45(4):986-992.

Conclusion

Create a device that enables existing analyzers to SELECTIVELY measure NO_2

- ✓ Linear conversion over a wide dynamic range:
  - ↳ From low ppb up to as high as 37ppm
- ✓ Simple external installation
  - ↳ Up to 7' away from the analyzer
- ✓ Fast response & high resolution
  - ↳ Making analyzers more robust
- ✓ Conversion efficiency >93%
  - ↳ Achieved up to 100% stable conversion
- ✓ Direct replacement for Mo converters
  - ↳ Low-cost add-on to existing analyzers
- ✓ Quality Assured data
  - ↳ Monitor the performance of your converter in realtime

And most importantly….

No extensive analyzer modifications required to install

Acknowledgements

Thank you to everyone who has contributed to this project, including:

Research and Development Team
Global Analyzer Systems Ltd

Other Collaborators:
Dr. Allan Legge

Questions?

Patent pending